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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.
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EXAMINER	
MOUTET, J	
ART UNIT	**PAPER NUMBER**
2826	

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MCDERMOTT WILL & EMERY
600 13TH STREET, N.W.
WASHINGTON DC 20005-3096

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Please find below and/or attached an Office communication concerning this application or proceeding.

Commissioner of Patents and Trademarks

PTO-90C (Rev. 2/95)
*U.S. GPO: 2000-473-000/44602

1- File Copy

Office Action Summary	Application No.	Applicant(s)	
	09/499,037	AIHARA ET AL.	
	Examiner	Art Unit	
	Johannes P Mondt	2826	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136 (a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☐ Responsive to communication(s) filed on _____ .

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) 1-6 is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) 1-6 is/are rejected.

7)☒ Claim(s) 4-6 is/are objected to.

8)☐ Claims _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are objected to by the Examiner.

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. § 119

13)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgement is made of a claim for domestic priority under 35 U.S.C. § 119(e).

Attachment(s)

15) ☒ Notice of References Cited (PTO-892)
16) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
17) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) 4 .
18) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
19) ☐ Notice of Informal Patent Application (PTO-152)
20) ☐ Other: .

DETAILED ACTION

Information Disclosure Statement

The examiner has considered the items listed in the Information Disclosure Statement.

Specification

The specification does not give as much information on the tantalum nitride films as is required to understand the bounds on the chemical composition needed for the invention. In particular, on page 10 Applicant does not specify the stoichiometry as defined by x in "TaN_x", which gives the impression that the value of x is not very important. However, on the next page Applicant quotes value for the work function of the tantalum nitride films used by Applicant of 5.41 eV and 4.95 eV, which is relatively high compared with the well-known value of 2.17 eV for TaN, i.e., for x=1, and so x must significantly deviate from 1. Because the aforementioned values of the work function are important in the arguments for the usefulness of tantalum nitride as witnessed by his comparison of the work functions of different tantalum nitride films Applicant is requested to amplify on the value of x in the specification.

Claim Objections

Claims 4, 5, and 6 are objected to because of the following informalities: "said indium oxide film", referring to the language of claim 3, on which claims 4,

5, and 6 all depend, is ambiguous, because two distinct indium oxide films are referred to in claim 3. Appropriate correction is required.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

1. Claim 3 is rejected under 35 U.S.C. 102(b) as being anticipated by Izumi et al (5,644,151). With reference to Fig. 1 and claims 16 and 20, Izumi et al teach a semiconductor (memory) device, comprising:

a capacitor lower electrode (storage node) or storage electrode 7 (column 5, lines 50-55) that specifically may include indium oxide (cf. claims 20 and 21) and is formed on a semiconductor substrate, namely one of the impurity diffused source/drain regions 2 and 3 (see column 5, lines 43-48);

a capacitor dielectric film 8 (column 5, line 53) that may specifically include tantalum oxide (cf. claims 16 and 17) and is formed on and in contact with an upper surface of aforementioned indium oxide film containing storage electrode; and

a capacitor upper electrode or cell plate electrode 9 (column 5, line 54) that may specifically include tantalum oxide (claims 20 and 21) and is formed on

and in contact with an upper surface of the aforementioned tantalum oxide containing capacitor dielectric film 8.

In summary, Izumi et al teach the device of claim 3.

2. Claim 4 is rejected under 35 U.S.C. 102(b) as being anticipated by Nishioka et al (5,811,851). With reference to Fig. 8) Nishioka et al teach a semiconductor device (column 2, lines 1-4) comprising:

a storage electrode including an oxide film that can be an indium oxide film 46+48 (see Table in column 7, under 46 Ruthenium, listing indium oxide as other alternate example for layer 46 and see column 8, under 48, listing indium oxide as alternative example for layer 48) formed on a semiconductor substrate 30 (column 5, lines 34-35) and further including a film that can be a tantalum nitride film 34 (see Table in column 7, under 34 mentioning nitrides as other alternate examples) formed beneath and contacting a lower surface of above mentioned indium oxide film;

a high-dielectric constant material layer or capacitor dielectric layer or film 42 that can be tantalum (pent)oxide (see Table in column 8 under 42, listing tantalum pentoxide as alternative example for layer 42) formed on and contacting an upper surface of above mentioned indium oxide film; and

an upper electrode or cell plate electrode layer or film 44 that can include an oxide film and thus a forteriori an indium oxide film (see Table in column 8 under 44, listing oxides, a forteriori indium oxide, as alternative example for layer

44) formed on and contacting an upper surface of above mentioned tantalum (pent)oxide film.

In summary, Nishioka et al teach the semiconductor device of claim 4.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

1. Claim 1 is rejected under 35 U.S.C. 103(a) as being unpatentable over Alers et al (6,265,260 B1) in view of the publication by Drynan et al (ISBN: 0-7803-4774-9). With reference to Fig. 1, Alers et al teach a semiconductor device (see "Field of Invention", column 1, lines 12-14) comprising:

a via or contact plug 26 (column 3, lines 15-17) formed on a semiconductor substrate 25 (column 3, lines 13-15);

a first electrode or storage electrode 30/31 comprising a first metal layer 30 (column 2, lines 41-41 and column 3, lines 23-28) formed on and contacting an upper surface of the contact plug 26 and in a preferred embodiment allowed (column 3, lines 27-29) to include a tantalum nitride layer or film 31;

a capacitor dielectric layer or film consisting of a tantalum (pent)oxide (Ta_2O_5; with reference to Applicant's disclosure) layer or film 33 (column 3, lines 53-54) formed on and contacting an upper surface of the aforementioned tantalum nitride layer or film; and

a second electrode or cell plate electrode 34 may preferably comprise metal comprised in the first metal electrode or first metal layer 30 (column 4, lines 22-25) which metal layer may be tantalum nitride (column 3, lines 26-27); said cell plate electrode 34 is formed on and contacting an upper surface of said tantalum (pent)oxide film 33.

Alers et al do not specifically teach the aforementioned via or contact plug 26 to include a tungsten film for low resistance. However, the use of tungsten for contact plugs in semiconductor integrated circuit capacitors has long been familiar to those of ordinary skills in the art, as witnessed by the publication "Shared Tungsten Structures for FEOL/BEOL Compatibility in Logic-Friendly Merged DRAM", by J.M. Drynan et al. Specifically, Drynan et al teach the use of tungsten-based contact plugs and via plugs, especially in tantalum (pent)oxide – dielectric capacitors for DRAM devices (see abstract and Fig.3), which is the kind of Applicant's invention. Therefore, it would have been obvious to one of ordinary skills in the art to modify the invention of Alers et al so as to include a tungsten film as contact plug.

2. Claim 2 is rejected under 35 U.S.C. 103(a) as being unpatentable over Alers et al (6,265,260 B1), referred to hereafter as Alers1, in view of Alers (6,271,596 B1), referred to hereafter as Alers2. As detailed above, Alers1 teach a semiconductor device comprising:

a storage electrode including a tantalum nitride film formed on and contacting an upper surface of a tungsten film that is part of a contact plug, said tungsten film being in an upper portion of the contact plug, formed on a semiconductor substrate; hence said storage electrode 30/31 including said tantalum nitride film 31 is formed on a semiconductor substrate 25;

a capacitor dielectric film including tantalum oxide film 33 formed on and contacting an upper surface of said tantalum nitride film 31; and

a cell plate electrode including a tantalum nitride film 34 formed on and contacting an upper surface of said tantalum oxide film.

Alers1 et al do not teach a copper film formed on and contacting an upper surface of tantalum nitride film 34 for improved low resistance. However, in another patent by Alers, on a capacitor structure and method of making a capacitor for use in semiconductor integrated circuits (column 1, lines 11-13, and 61-65), teaches a capacitor based on tantalum (pent)oxide as the dielectric material (hence closely related to the field of Applicant's invention), in which (cf. Fig. 3), as is the case in Alers1, the tantalum nitride layer or film 303 serves as top capacitor plate (column 5, lines 15-18), or cell plate electrode as it is called in Alers1, while a metal layer or film (numeral 308 in Alers2) is formed on and

contacts the upper surface of aforementioned tantalum nitride layer or film (numeral 303 in Alers2). As possible material for the aforementioned metal layer or film Alers2 mentions copper (column 4, lines 37-40). Therefore, it would have been obvious to one of ordinary skills in the art to modify the invention by Alers1 at the time it was made so as to include a copper film formed on and contacting the upper surface of the tantalum nitride film 34.

3. Claims 5 and 6 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nishioka et al (5,811,851) in view of Alers (6,271,596 B1), which will be referred to as Alers2 in contradistinction with the other reference referred to above to a patent by the same first inventor.

With regard to claim 5: as detailed above, claim 3, on which claim 5 depends, is anticipated by Nishioka et al. Nishioka et al do not teach the inclusion in the cell plate electrode of a copper film formed on the indium oxide film for improved low resistance. However, Alers2, in a patent on a capacitor structure and method of making a capacitor for use in semiconductor integrated circuits (column 1, lines 11-13, and 61-65), teaches a capacitor based on tantalum (pent)oxide as the dielectric material (hence closely related to the field of Applicant's invention), in which (cf. Fig. 3) in which a metal layer or film (numeral 308 in Alers2) is formed on and contacts the upper surface of the upper electrode layer or film (numeral 303 in Alers2). As possible material for the aforementioned metal layer or film Alers2 specifically refers to copper (column 4,

lines 37-40). Therefore, it would have been obvious to one of ordinary skills in the art to modify the invention by Nishioka et al at the time it was made so as to include a copper film formed on and contacting the upper electrode indium oxide layer or film.

With regard to claim 6: claim 5, on which claim 6 depends, has been shown above to be unpatentable over Nishioka et al in view of Alers2, while Alers2 actually teach a tantalum nitride layer or film 303 underneath the metal layer or film 308, and thus it would have been obvious to one of ordinary skills in the art to modify the invention at the time it was made further so as to include a tantalum nitride layer or film in accordance with the invention of claim 6.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Johannes P Mondt whose telephone number is (703) 306-0531. The examiner can normally be reached on 8:00 am - 5:30 pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nathan J Flynn can be reached on (703) 308-6601. The fax phone numbers for the organization where this application or proceeding is assigned are (703) 308-7722 for regular communications and (703) 308-7724 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-0956.

JM
August 24, 2001

Nathan Flynn
Primary Examiner